MSc. Thesis VIBOT

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Abstract

The abstract will go here....

Research is what I'm doing when I don't know what I'm doing. . . .

Werner von Braun

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Acknowledgments

Any acknowledgements???

Chapter 1

Introduction

1.1 Why underwater?

Manhood has managed to conquer variety of environments. At some point, humans could walk on the moon, send expeditions to cold or remote areas in different corners of the planet. Sea-floor constitutes the largest part of Earth's surface.

1.1.1 Localization - Where the Robot Is?

One of the main capabilities of the autonomous underwater vehicle is knowing to localize itself within an environment. To estimate its metric position and orientation in three dimensional space. Knowing where it actually is enables further tasks such as path tracking or various manipulation tasks. Therefore, it has the same role as parts of the human brain devoted to navigation.

The main topic is localization of an underwater vehicle. Localization essentially deals with the problem of the estimation of the position of the vehicle. A tool to accomplish it is the sensor measurement. Main idea is to establish the matching between the sensor measurements and the map elements. This process is not straightforward since many conditions influence the performance, including the very starting point of the localization: whether we have some previous estimate on the position or not [**?**]. Localization can be carried through by analysing the pose possibilities and choosing the one that reaches better coherence between the measurements and the map. Such methods are Monte Carlo localization and Markov localization. The other approach, a set of hypotheses for coupling together the sensor measurements and the map features. These hypotheses are ranked depending on number of consistent matches where the one with highest ranking is defining the position. This can be a costly process, therefore a number of methods deals with optimization of it.

using Kalman filter. Mathematical background is in: [**?**].

1.2 Literature review

Mention the PhD thesis [**?**].

Localization exploring map or scan matching techniques was presented in [**?**] and [**?**].

Approach that uses geometrical landmarks in Kalman filters is explained in [**?**]. These led to SLAM.

One work from HW is [**?**].

Chapter 2

Problem Definition

The aim of the project is to implement and evaluate navigation algorithm for an underwater vehicle. Navigation, as introduced in literature, implies two capabilities [**?**]:

- localization - accurate determination of the vehicle position and velocity with respect to a known reference point
- planning and the execution of the movements between locations

The work presented in the thesis will emphasize the first capability. Moreover, the first capability is a necessary step in carrying out the second capability correctly. To accomplish the task, sensor information is integrated in calculations. The purpose is to calculate the vehicle position in every moment as accurately as possible. Mathematical tool that will integrate the measurements and establish the final estimate is well known Kalman filter [] algorithm. More details about Kalman filter in chapter .

It is important to mention that localization under water tends to be different challenge compared with the localization on land or in the air. Namely, the usage of GPS signal is limited since it is available only on water surface. Therefore, speed and heading information obtained from inertial navigation system (INS) sensors is used together with the mathematical model of the motion to calculate the position, orientation and velocity via dead reckoning. Such strategy eventually leads to progressive error since measurement errors are integrated each time. To overcome this, GPS information which gives absolute distance is used to make corrections. It updates the position information whenever available - either directly, if the vehicle is on the surface or using long baseline acoustic positioning (LBL).

Another obstacle in managing localization is water environment itself. Usage of sensors based on light transmission such as camera, is limited because environment is such that it deforms or decreases the signal. A useful tool to determine the distance or the speed in water is sound, a mechanical wave that does not severely depend on light conditions and moves faster in water.

Chapter 3

State of the art

This chapter gives an overview of the methods and existing algorithms for underwater vehicle localization. Localization is influenced with the development sensor devices. Sensors can be regarded as the tool for managing the localization. Faster they are, more accurate they are, localization has more chances to be better. Chapter § 4 gives more insight into performance of each sensor device used for underwater vehicle navigation. Following paragraphs are revising the ways to process such sensor information.

In existing survey on underwater vehicle navigation, Kingsey et al. [**?**] already give a summary presenting some methods used. As introduced in [**?**], current vehicle position is named navigation state - a vector where the vehicle is and how it is oriented in space. Localization simply means finding a way to estimate navigation state vector. Naturally, sonsors provide the data for estimation.

The most simple approach would be to take the raw sensor measurements and use them directly or within a simple mathematical model that describes the vehicle dynamics. However, many techniques utilize sensor data as supplementary information with the information from the kinematic model. Rough classification would categorize localization methods on stochastic state estimators (Section **??**), simultaneous localization and mapping approach (SLAM, Section **??** and localization based on deterministic observers [**?**].

3.1 Stochastic state estimators

3.2 SLAM

3.3 Deterministic state estimators

Chapter 4

Sensors

This chapter gives an overview of the sensors used in localization of a Nessie underwater vehicle. Localization of a vehicle

Appendix A

The first appendix

If you need to add any appendix, do it here... Etc.